CORNING GLASS WORKS
ELECTRO-OPTICS DEPARTMENT
RALEIGH, NORTH CAROLINA

IMPROVED SCREEN FOR REAR-PROJECTION VIEWERS

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1. Introduction

The crossed-cylinder lenticular screen continues to show promise as experimental work on it proceeds. A ruling engine has been used to rule a 6" x 6" master from which epoxy replicas have been made, after suitable intermediate replication. The lenticules have a 2 mil spacing and a radius of 1.4 mil. The thin lenticular sheet of epoxy is allowed to harden in contact with a substrate of such a thickness as to result in a total thickness of about 2.8 mils, the focal length of the lenticules. Thus a parallel beam of light incident on a lenticule focusses onto a line at the rear surface of the film as described in P-19-33 and P-19-37. The steps in fabrication are 1) casting the epoxy lenticules and getting them to adhere uniformly to the substrate, 2) applying a mask onto the rear of this substrate to allow only focussed light to pass through, and 3) bonding the masked surface onto the smooth side of a second lenticular sheet, unmasked and with lenticules oriented at 90° to those of the first sheet. Because of the flexibility of the lenticular sheets, a stiff intermediate substrate may also be incorporated.

2. Epoxy Lenticules on Various Substrates

The following substrates have been tried or are being tried:

a) 2 mil DuPont Mylar sheet, untreated
b) 2 mil DuPont Mylar sheet, roughened
c) 2 mil DuPont Mylar sheet, commercially treated to promote epoxy bond.
d) 4 mil polyester with diazo masking layer
e) 1/8" clear Plexiglas plastic sheet
f) 2.5 mil Kodak Estar, antihalation backing washed off
g) 3.25 mil triacetate photographic film support with subbing but no emulsion.
h) 5.25 mil triacetate photographic film support with antihalation backing washed off.
i) 2.5 mil Kodak Estar support with 649 GH emulsion

Epoxy lenticules have been successfully cast and have bonded to substrates a, b, c, d, e and f with varying degrees of reliability. Since the epoxy did not bond well with untreated Mylar polyester sheet, several methods of improving this bond were attempted. Mechanical roughening of the substrate promoted bonding but left visible scratches. A commercial treatment for this purpose produced indifferent results. A firm bond was formed with Kodak Estar photographic film support having the antihalation backing removed. This was done by developing, fixing, and washing the unexposed film, presumably leaving a bond-promoting sublayer on the no-emulsion side. The triacetate photographic film supports are being tried to determine whether both lenticule bonding and subsequent bonding operations might be easier. Finally, anticipated success with the 649 GH emulsion on 2.5 Kodak Estar will provide lenticular sheet with attached masking layer, which can then be suitably exposed and developed.

3. Masking

Our first intention was to allow the lenticules to bond onto the substrate, then apply the masking material to the opposite surface by photoresist or photographic techniques. In any case the opaque and clear stripes of the mask were to be self-registering with respect to the lenticules. That is, each lenticule was to form its own clear focal-plane aperture by bringing a suitable incident light distribution to focus on a positive photosensitive layer on the back of the lenticular sheet.

Preliminary experimentation with the photoresist approach was not encouraging, so photographic means were then investigated. At about the same time it was realized that it might well be possible to apply the lenticules to the back of existing photographic film, thus greatly simplifying the fabrication problem. The diazo on 4-mil polyester sheet (substrate d above) was the first attempt in this direction, but the developed diazo layer was judged inferior to a photographic emulsion for this purpose. A special lot of high resolution photographic film with no antihalation backing and capable of forming a positive image was then ordered. This was Kodak 649 GH emulsion on 2.5 mil Estar polyester support (substrate i). Meanwhile we found that good lenticule adhesion was obtained on Kodak Estar (substrate f) with antihalation backing washed off. Casting of the lenticules on substrate i is currently in progress.

4. Bonding to Second Set of Lenticules

Experimentation with a large number of bonding materials led to the choice of either Eastman 910 adhesive or Summer Laboratories' Lensbond optical cement for the bonding of photographic emulsions to polyester sheet or to glass. The Eastman 910 adhesive was found to produce a stronger bond but more distortion of the interface upon setting. The Lensbond optical cement produced a uniform, but only moderately strong, bond and less distortion. There was much less distortion when the thin polyester sheet or the emulsion were bonded to a glass plate.

5. Non-self-registering Test Model

In order to provide a small test model without waiting for delivery of the special emulsion and substrate, we employed a standard high-resolution positive photographic plate as follows. A 2" x 2" lenticular sheet was placed with its flat surface in contact with the emulsion side of the plate. Semicollimated light was projected onto the lenticules, forming the mask pattern on the emulsion. The two parts were then separated, the emulsion was developed, and they were reassembled using optical cement. Registry of lenticules and mask appeared to be quite good for this small area. To complete the screen for test purposes, the second set of lenticules was simply "oiled" onto the glass side of the photographic plate using water as the index matching fluid.

An incident parallel beam was spread by this assembly into an approximately square solid angle measuring ± 22° vertically and horizontally. The total transmittance T_{90} was 64%. Since nearly all the light fell within a ± 30° circular region, we can say that T_{30} is of the order of 60%. A single set of unmasked lenticules transmitted 87% while the single set of masked lenticules transmitted 70%. Thus the mask may be obscuring as much as 20% of the light incident on it.

Contact resolution with the unaided eye was comparable with that of good scattering screens. The MTF has not yet been measured. In a projection arrangement, this lenticular screen appeared bright and rejected ambient light well. The diffraction pattern associated with the regular spacing of the lenticules was dim as compared with the undiffracted light but was noticeable. Steps will be taken to eliminate this effect in future master rulings.

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